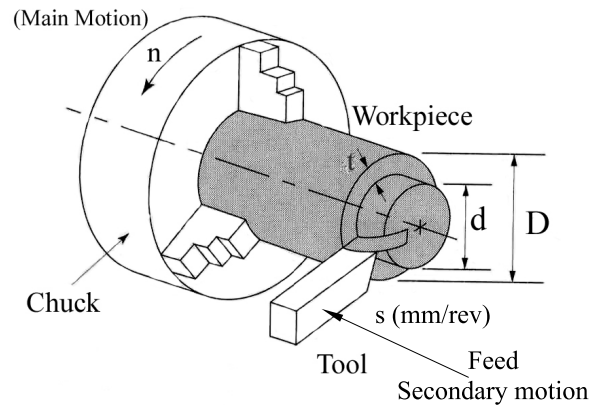


6 Turning Operation

6.1 Basic concept of turning operation

Turning is the method of machining used for production of rotary components. Machine tool for turning is called center lathe. Cutting tool having one point is named as turning tool.

The main motion is rotary by the workpiece in (r.p.m) - rotary speed. The secondary motion is rectilinear by the tool in mm/rev and is the feed rate.



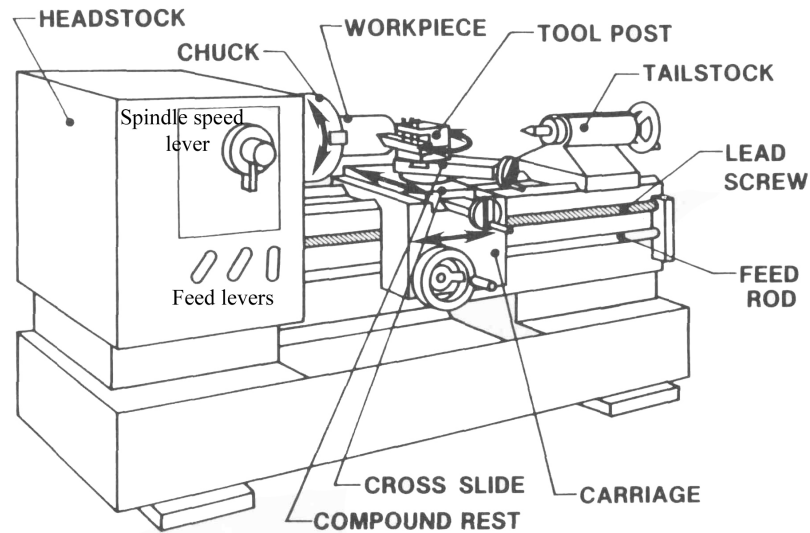
The cutting speed (v) is given by:

$$v = \frac{\pi D n}{1000}$$

The depth of cut (t) is:

$$t = \frac{D - d}{2}$$

6.2 Main parts of the center lathe:

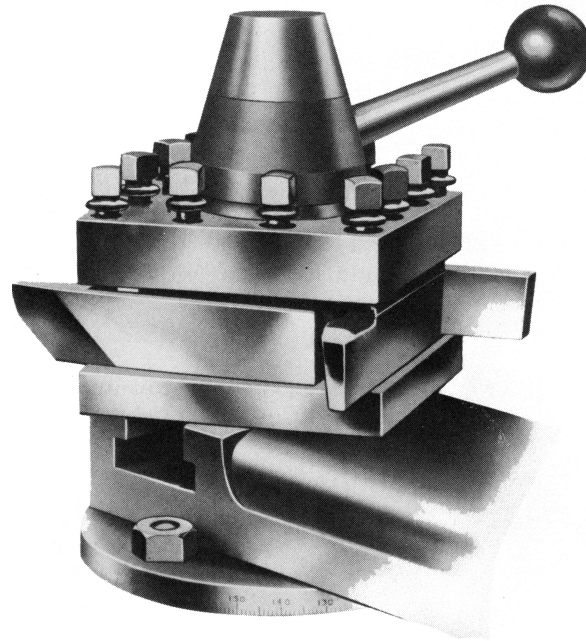


Engine lathe

6.3 Clamping of the turning tool

1- Clamping plate

2- Tool post with spherical rest

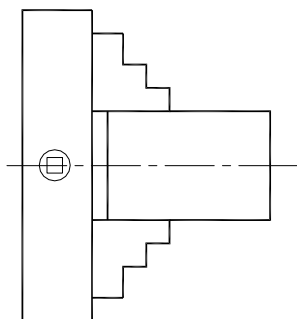
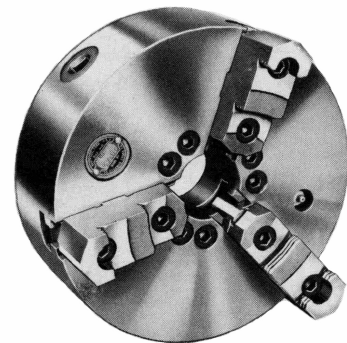


Tool post (four-way)

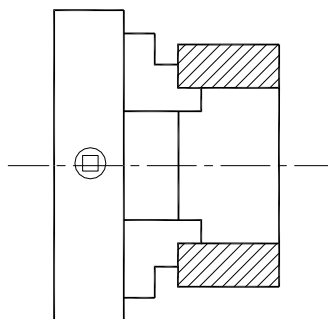
6.4 Clamping of workpiece is carried out by:

1. Universal chuck

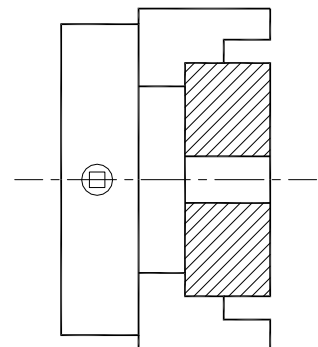
It has three jaws that work at the same time. It is used for symmetrical and short workpieces.



Jaws in normal position, holding on outer diameter (OD) of bar stock



Jaws in normal position, holding on inner diameter (ID) of tubing

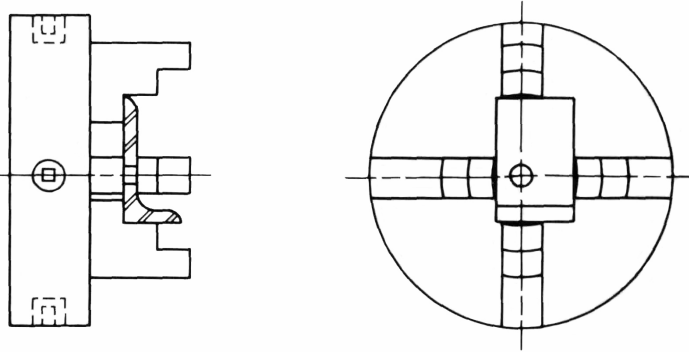


Jaws in reversed position, holding on outer diameter (OD) of a plate

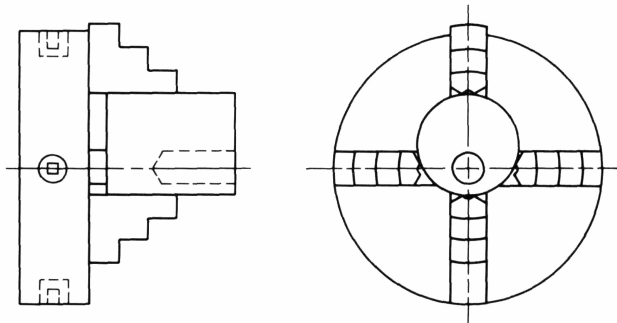
2. Four jaws independent chuck (face plate)

It has four jaws which are moved separately using a chuck key for each jaw. It is used for unsymmetrical (irregular) shapes.

Note: Fourth jaw omitted for clarity.



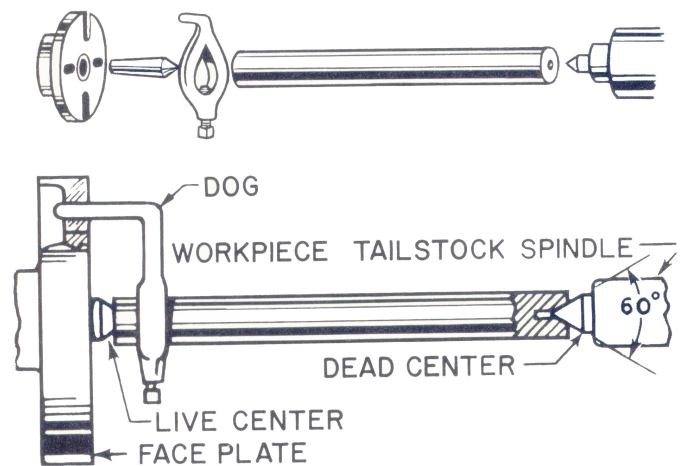
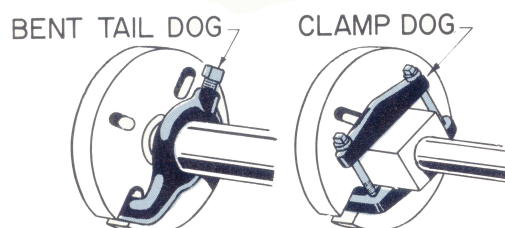
Drilling off-center hole in a piece of angle iron



Drilling off-center hole in round bar

3. between two centers

Two centers are used to support the workpiece for turning between the headstock and tailstock. It is used for clamping long workpieces.

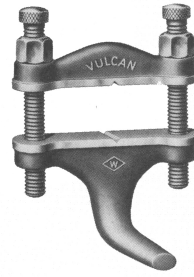




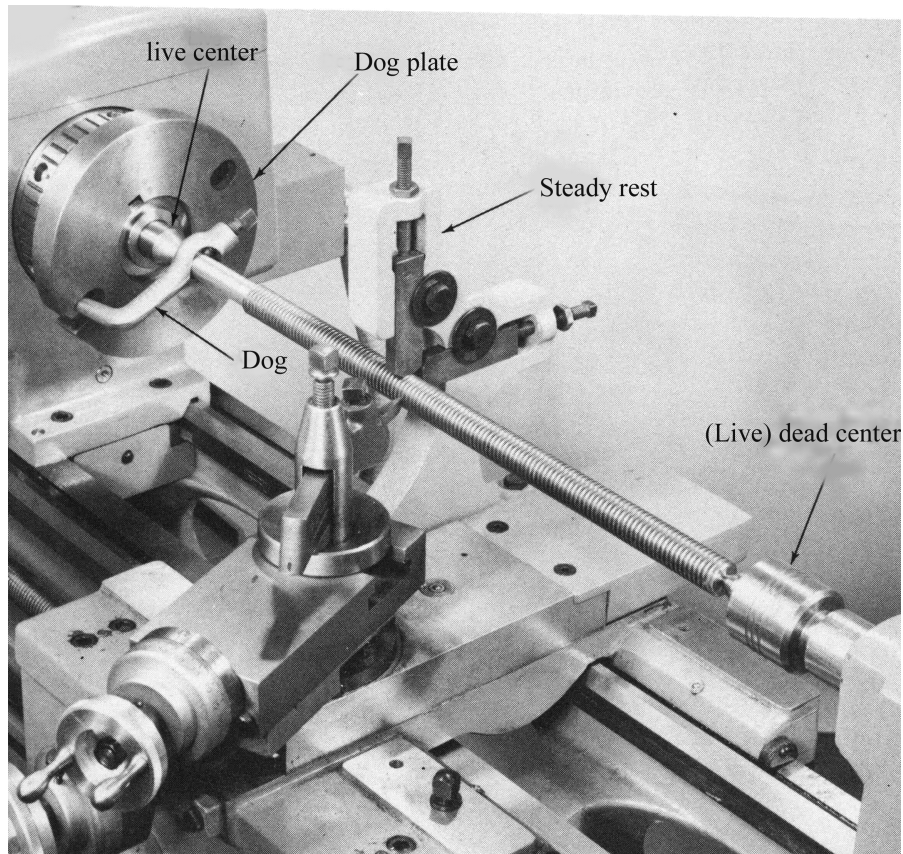
Headless screw



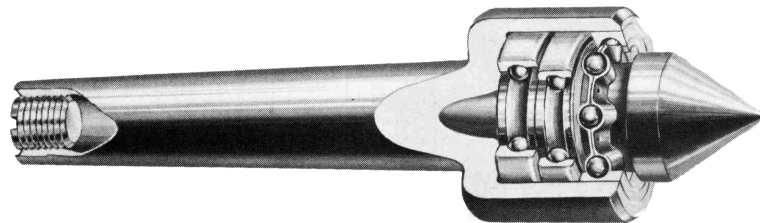
Heavy service



Universal dog for round and square workpieces

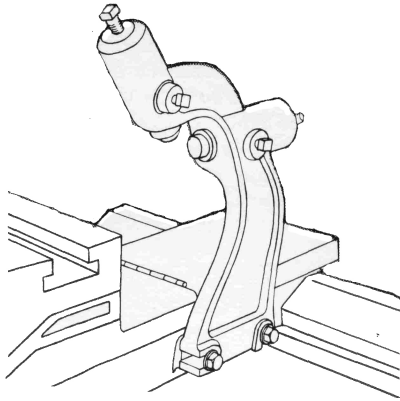


Mounting between centers

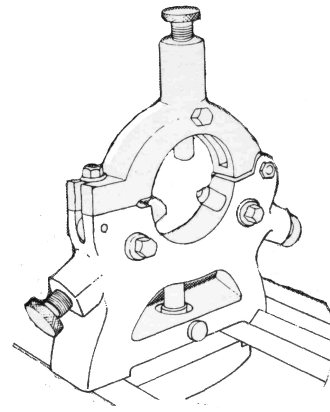


Live center showing the thrust bearings

4. Follow rest and steady rest



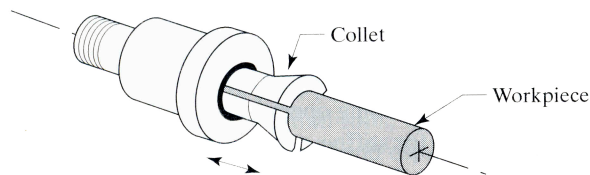
Follow rest is attached to the carriage and provides moving support for the workpiece



Steady rest is mounted on guide ways when needed to support long slender workpieces

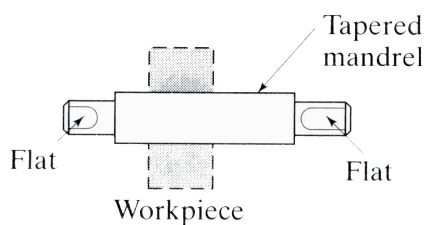
5. Collet chucks

They are made to hold workpieces that are close to a specific diameter (used mainly for mass and lot production).

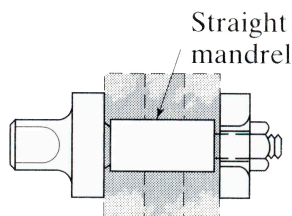


6. Mounting on the ordinary mandrel

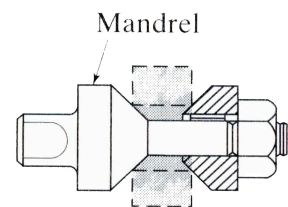
A mandrel is a solid steel bar with a slight taper. It is used to clamp a hollow and short workpiece. There are various types of mandrels to hold workpieces for turning. These mandrels are usually mounted between centers on a lathe. Note that in (a) both the cylindrical and end faces of the workpiece can be machined, (b) and (c) only the cylindrical surfaces can be machined.



(a) Solid mandrel



(b) Gang mandrel

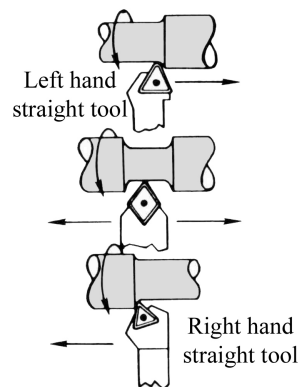


(c) Cone mandrel

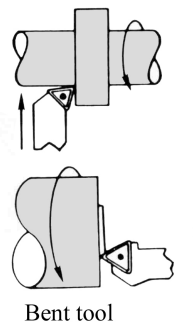
6.5 Cutting operations in turning

6.5.1 External turning

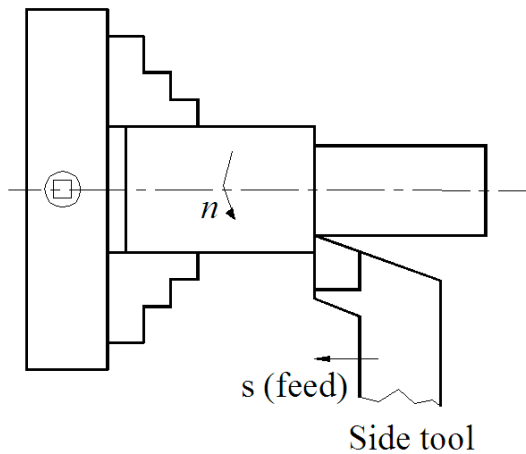
1. Longitudinal turning



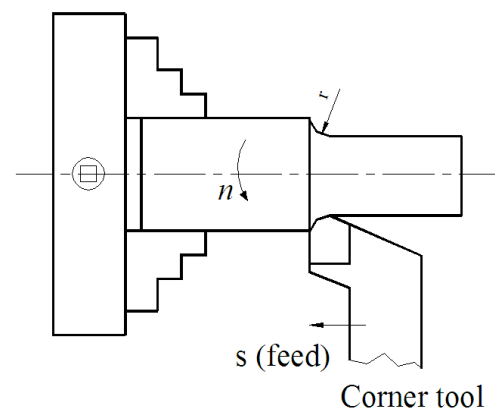
2. Facing



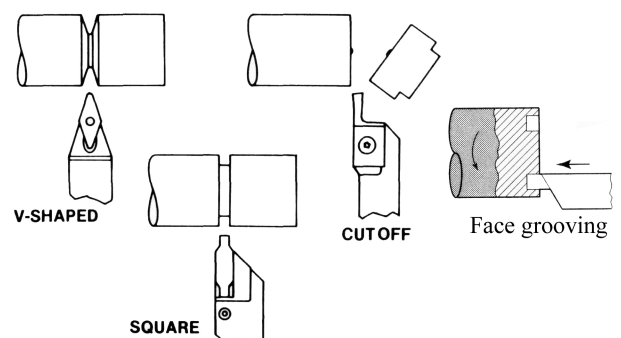
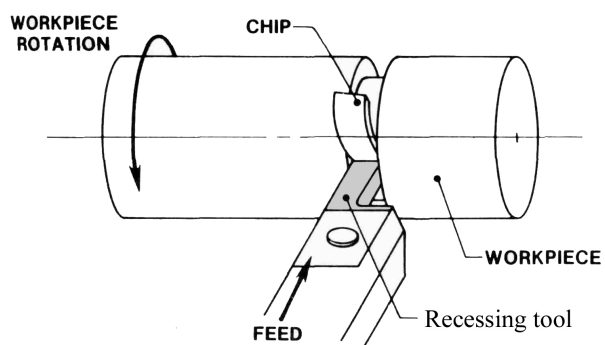
3. Side turning



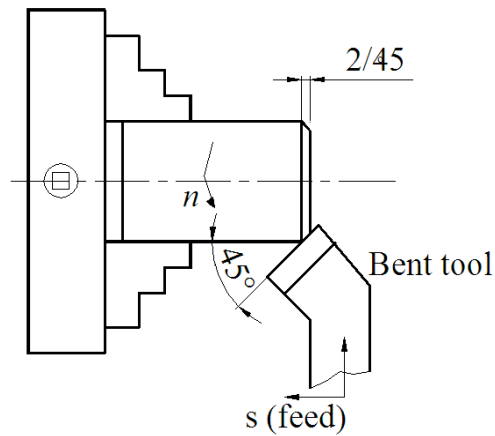
4. Cornering



5. Grooving (recessing) and cutting-off

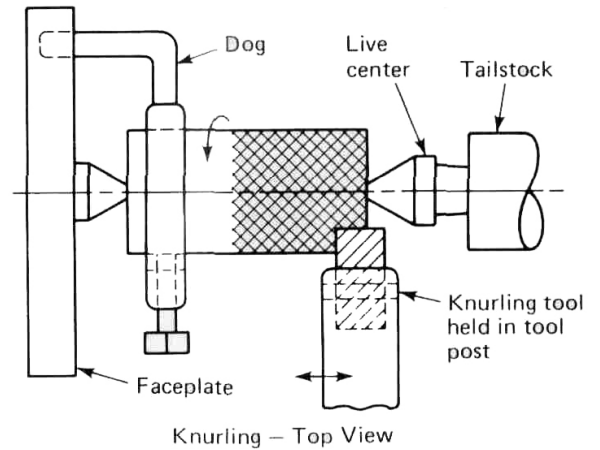


6. Chamfering



7. Knurling

Knurling is the process of pressing a diamond-shaped or straight-line pattern on the workpiece surface.



8. Thread cutting on the lathe

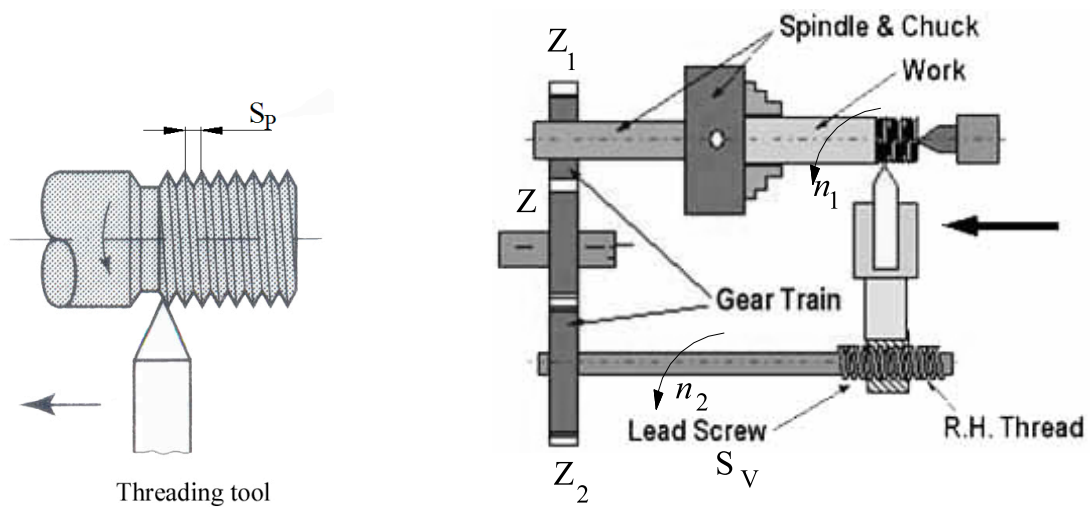
External thread cutting with the thread cutting tool. When thread cutting the lead screw transmits the motion from the spindle by means of the gears (gear box) to the carriage.

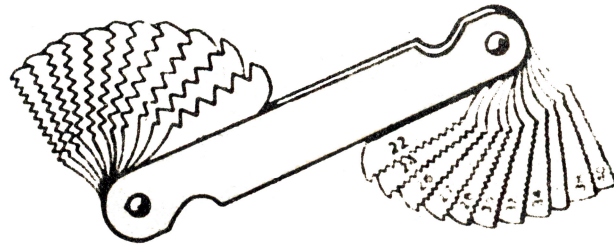
$$\frac{S_p}{S_v} = \frac{n_2}{n_1} = \frac{Z_1}{Z_2}$$

Where:

S_p is the lead of the workpiece thread

S_v is the lead of the lead screw of the lathe machine.



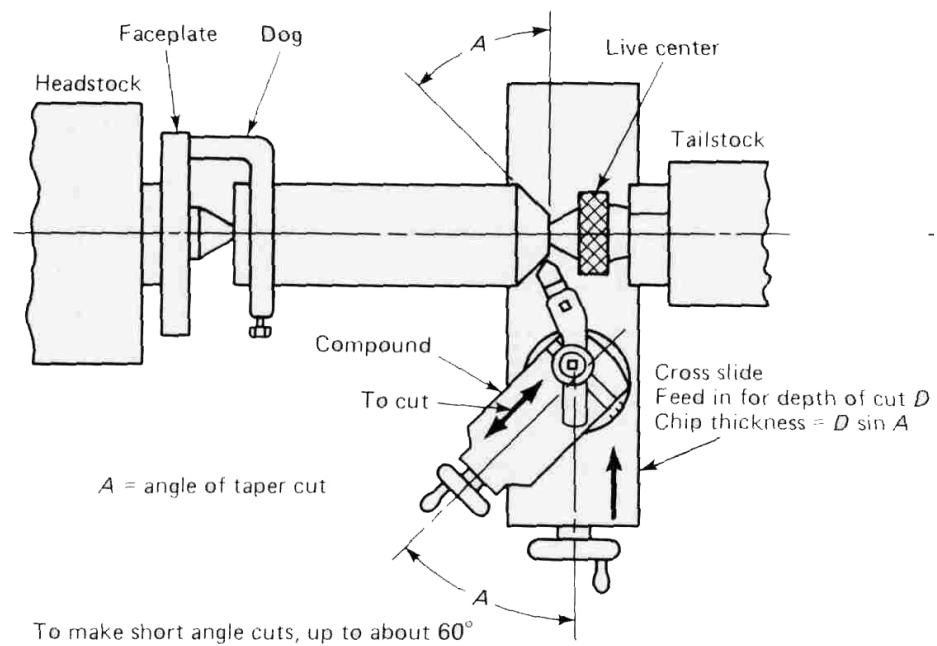


Screw-pitch gauge

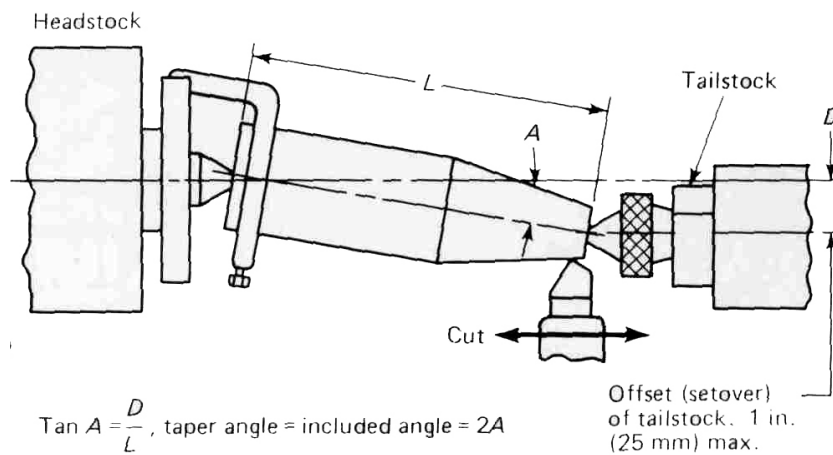
9. Taper turning

There are three ways to turn the taper:

- a) With the tool slide - for any taper

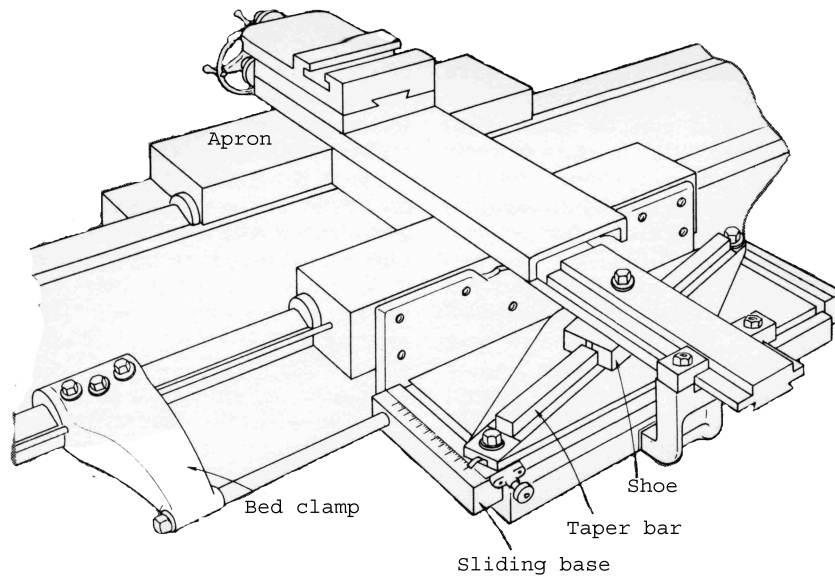


- b) By the tailstock transverse adjustment (transversal shifting) - for long tapers.



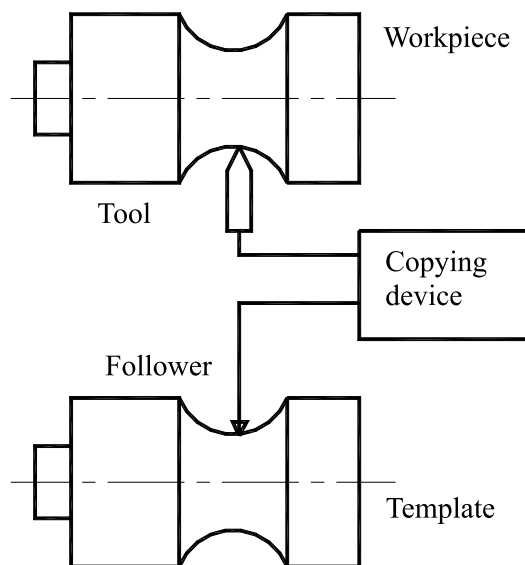
To cut a long, shallow taper. Angle A is exaggerated in the drawing

c) With a taper turning attachment - up to 15 •



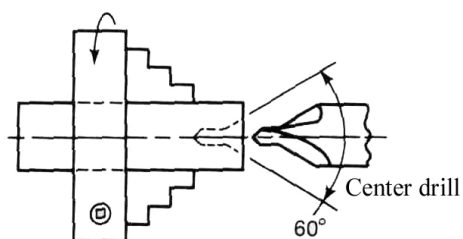
Taper attachment moves cross slide transversely when carriage moves, but only if the bed clamp is fastened. Taper bar is set for the angle to be machined.

10. Copy turning

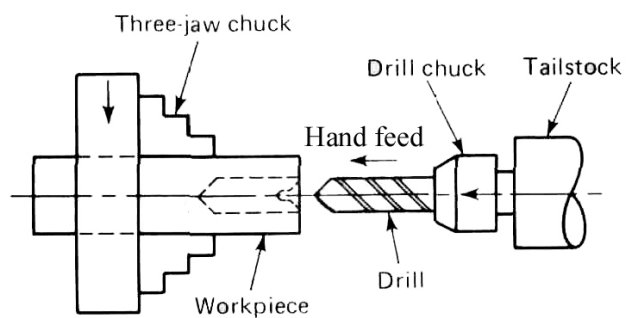


6.5.2 Internal turning

1. Centering

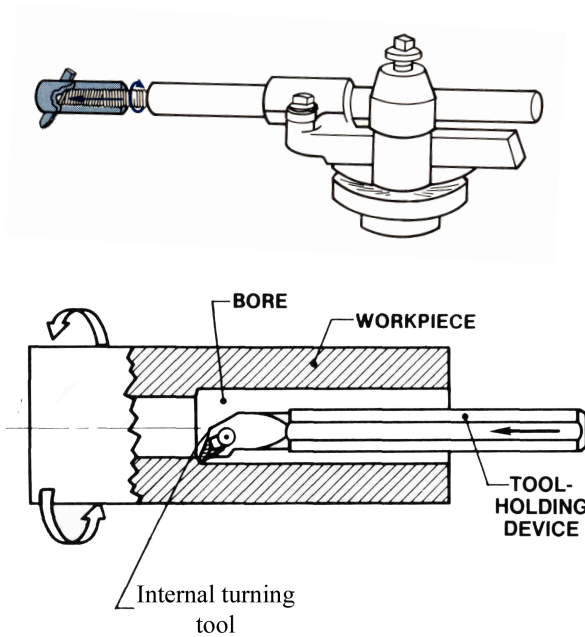


2. Drilling

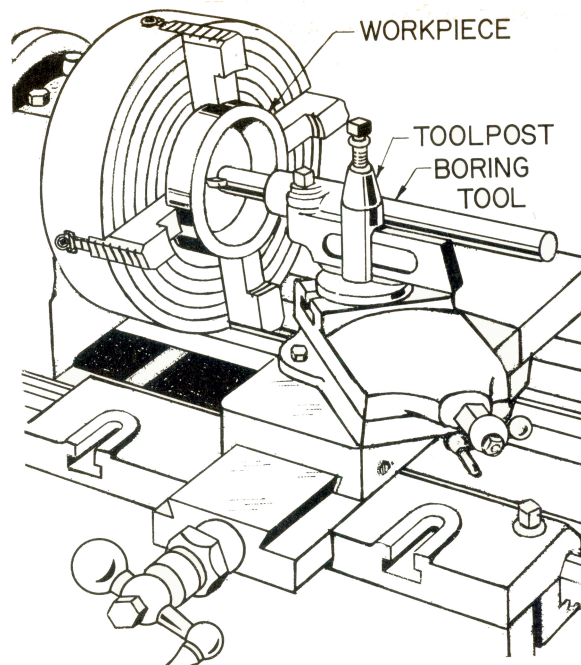


3. Boring on lathe machine

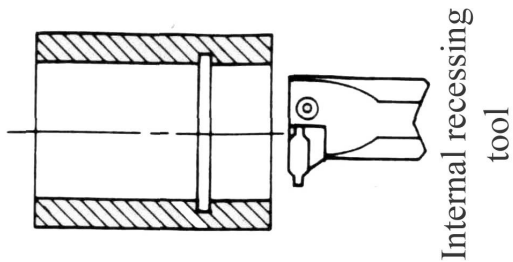
Boring is the method of machining used for enlarging the hole that has been drilled or cast into the metal.



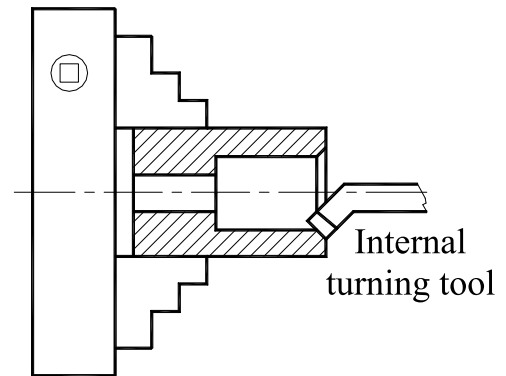
Boring bar for tool bits



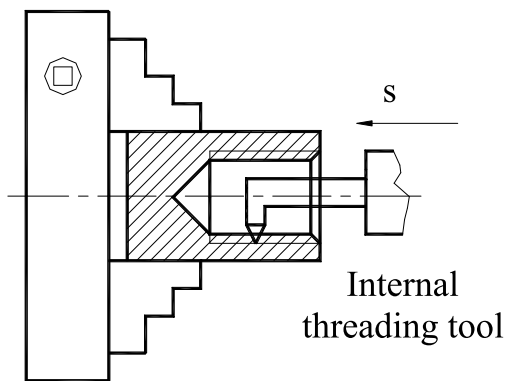
4. Internal recessing



5. Internal chamfering

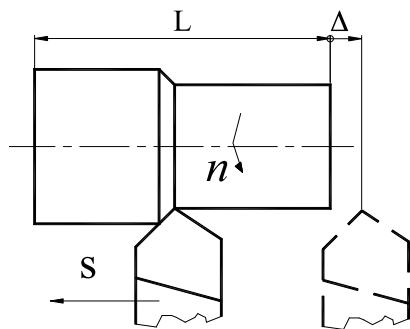


6. Internal threading



6.6 Calculation of machining time when turning

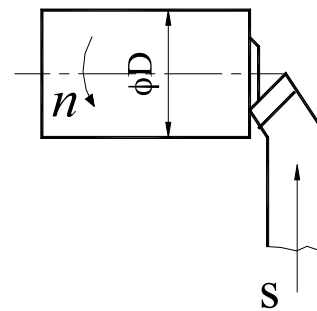
6.6.1 Longitudinal turning



$$t_m = \frac{L + \Delta}{s n}$$

where Δ is the tool approach (2 – 5 mm)

6.6.2 Face turning



$$t_m = \frac{D/2 + \Delta}{s n}$$

6.7 Main types of turning machines

- 1- Center lathe (used for piece production)
- 2- Turret lathe (used for lot or batch production)
- 3- Automatic lathe (used for mass production)
- 4- Special purpose lathes
- 5- Bench lathe

6.8 Accuracy and surface roughness for turning operation

Grad of accuracy	IT = 8 up to 12
Surface roughness R_a	= 1.6 up to 12.5 μm